CR-124925

EARTH SATELLITE CORPORATION

(EarthSat)

1771 N STREET, N.W., WASHINGTON, D.C. 20036 / (202) 785-1123

January 3, 1973

National Aeronautics and
Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

ATTENTION: Distribution

RE: Bi-Monthly Progress Report - SR #141:
ERTS-1, Snow Enhancement: NAS5-21744

Gentlemen:

Earth Satellite Corporation (EarthSat) is pleased to submit a progress report for the period of October 31, 1972 to December 31, 1972. To facilitate NASA's review, a consistent format has been adopted for all progress reports prepared by Geosciences and Environmental Applications Division. A Task Status Report can be referenced in Appendix A.

A. TITLE: Facilitating the Exploitation of ERTS-Imagery Using Snow Enhancement Techniques (SR #141) - NAS5-21744

B. PRINCIPAL INVESTIGATOR: Dr. Frank J. Wobber (P511)

C. CONTRIBUTORS: Dr. Frank J. Wobber
Mr. Kenneth Martin
Mr. Charles Sheffield
Mr. Orville Russell
Mr. Roger Amato

D. SUMMARY OF ACCOMPLISHMENTS: Emphasis during this reporting period was placed on expanding EarthSat's snow depth recording network, analyzing ERTS snow-free frames of the test area and ordering analytical materials (e.g. CCT, precision 9.5 inch negatives and 9.5 inch positive transparencies) to conduct intensive analysis of imagery of the test areas. Principal accomplishments during this period include the following:

- Low intensity zones of snow depth reporting within EarthSat's postcard network for the New England Test area have been identified. Newspapers within these areas have been contacted with an ERTS Experiment Information Package (Appendix B) in an effort to enlist volunteer support and supplement public reporting networks.

- Readers indicating their desire to participate in the experiment are being notified of data collection requirements and are being

sent a supply of Snow Depth Reporting Postcards (Appendix C).

- A snow depth recording system has been designed to display snow depth information. Specially drafted base maps which display the locations of all reporting observers have been commercially reproduced to allow weekly tabulation and display of snow depth information.

- Excellent quality ERTS-1 transparencies (1096-15072 and 1096-15065) of the primary test area (New England) have now been received and are being analyzed. Digital tapes of these frames have been ordered to implement automated enhancement procedures.

- A lineament overlay has been prepared from analysis of high altitude (1:250,000) photo index mosaics as a supplemental source in the geological validation of interpreted lineaments.

- A working photo-annotation system (Appendix D) has been designed to standardize lineament mapping.

- A sequential system for lineament validation has been conceptualized (Appendix E).

- The Data Analysis Plan has been submitted to the ERTS Contracting Officer and approved.

- Draft versions of sections I and II (Introduction and Background) of the Final Report have been written in an effort to prepare portions of the Final Report as the experiment progresses.

E. SIGNIFICANT RESULTS:

- EarthSat has established an effective mail-based method for obtaining timely ground truth (snow depth) information over an extensive area. The method is both efficient and inexpensive compared with the cost of a similarly scaled direct field checking effort.

- Additional geological information has been acquired, which is not shown in geological maps in the area.

F. PROBLEMS:

- The inferior quality of many paper prints does not allow direct mapping of fracture data. Unanticipated costs are accruing from increased time required for analysis of substandard images and need for in-house print enlargements to replace low quality paper prints. The Technical Monitor has been notified of the processing problems; low quality prints have been returned to Goddard.

G. RECOMMENDATIONS FOR TECHNICAL CHANGES: None

H. CHANGES TO STANDING ORDER FORMS: None

I. OVERVIEW OF INVESTIGATION:

Excellent quality snow-free ERTS-1 transparencies of the New England test area (1096-15072 and 1096-15065) and the Maryland-Virginia area (1080-15192) have been received and are now being intensively analyzed. Additional fracture information has been acquired from the imagery which is not present on available geological maps of the area. NASA aircraft coverage of the test areas will be acquired on January 22, assuming sufficient snow cover exists in one or both test areas.

Sincerely yours,

Frank J. Wobber
Director
Geosciences and Environmental
Applications Division

FJW/rlt

ATTACHMENTS

Dr. Frank J. Wobber SR #141 NAS5-21744

SIGNIFICANT RESULTS

October 31, 1972 - December 31, 1972

- EarthSat has established an effective mail-based method for obtaining timely ground truth (snow depth) information over an extensive area. The method is both efficient and inexpensive compared with the cost of a similarly scaled direct field checking effort.
- Additional geological information has been acquired, which is not shown in geological maps in the area.

January 12, 1973

PROGRESS REPORT SUMMARY

Reporting Period: October 31, 1972 - December 31, 1972

CATEGORY: 8-Interpretation Techniques Development

SUB-CATEGORY: C-General

TITLE: Facilitating the Exploitation of ERTS-Imagery Using Snow Enhancement Techniques - SR #141: NAS5-21744

PRINCIPAL INVESTIGATOR: Dr. Frank J. Wobber (P511)

CO-INVESTIGATOR: Mr. Kenneth R. Martin

SUMMARY:

During this reporting period, EarthSat's existing ground truth (snow depth) reporting networks were expanded. Newspapers were contacted within both the primary New England test area (Massachusetts and Connecticut) and the secondary test area in Maryland and Virginia to enlist public support. Newspapers were selected in areas lacking snow depth observers and requested to feature an article briefly describing the ERTS program, the Snow Enhancement experiment and to present an appeal for public support. Significant public interest in the experiment and ERTS program was found to exist. Readers have written to express a desire to participate as ground truth (snow depth) observers. These observers will supplement the existing network (coordinated by EarthSat) which continues to report snow depth data on a weekly basis.

Excellent quality snow-free ERTS-1 transparencies of the New England test area (1096-15072 and 1096-15065) and the Maryland - Virginia area (1080-15192) have been received and are now being intensively analyzed. Additional fracture information has been acquired from the imagery which is not present on available geological maps of the area. NASA aircraft coverage of the test areas will be acquired on January 22, assuming sufficient snow cover exists in one or both test areas.

ERTS IMAGE DESCRIPTOR FORM

(See Instructions on Back)

NDPF USE ONLY
D
N
ID

DATE November 1, 1972

PRINCIPAL INVESTIGATOR Frank J. Wobber

GSFC

ORGANIZATION EarthSat

PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*			DESCRIPTORS
	Lake	River		
1005-15005-4 01 1005-15005-6 01 1005-15005-7 01	X X X	X X X		Alluvial Plain Barrier Bar Basin Coast Line Coast Plain Dendritic Drainage Geofracture Island Lineament Meander Piedmont River Fault
1023-15005-4 01 1023-15005-5 01 1023-15005-6 01 1023-15005-7 01 1077-15011-4 01 1077-15011-5 01 1077-15011-6 01 1077-15011-7 01	X X X X	X X X X		Basin Coast Line Lineament Piedmont River
1023-15003-4 01 1023-15003-5 01 1023-15003-6 01 1023-15003-7 01	X X X X	X X X X		Coastal Plain Coast Line Dendritic Drainage Lake Lineament Meander Piedmont River

*FOR DESCRIPTORS WHICH WILL OCCUR FREQUENTLY, WRITE THE DESCRIPTOR TERMS IN THESE COLUMN HEADING SPACES NOW AND USE A CHECK (✓) MARK IN THE APPROPRIATE PRODUCT ID LINES. (FOR OTHER DESCRIPTORS, WRITE THE TERM UNDER THE DESCRIPTORS COLUMN).

MAIL TO ERTS USER SERVICES
CODE 563
BLDG 23 ROOM E413
NASA GSFC
GREENBELT, MD. 20771
301-982-5406

GSFC 37-2 (7/72)

ERTS IMAGE DESCRIPTOR FORM

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DATE December 15, 1972

PRINCIPAL INVESTIGATOR Frank J. Wobber

GSFC

ORGANIZATION EarthSat

PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*			DESCRIPTORS
	River	Lake	Ridge	
1079-15122-601	X	X	X	Anticline
1079-15122-701	X	X	X	Bedrock
				Dendritic Drainage
1061-15120-401				Fault
1061-15120-501	Cloud-covered-		70%	Geofracture
1061-15120-601				Lineament
1061-15120-701				Monoclinal Valley
				Mountain
				Massif
				Rectangular Drainage
				Thrust Fault
				Valley

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PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*			DESCRIPTORS
	Lake	River	Ridge	
1045-15243-4 01	X	X	X	Anticlinal Mtn.
1045-15243-5 01	X	X	X	Anticlinal Valley
1045-15243-6 01	X	X	X	Alluvial Terrace
1045-15243-7 01	X	X	X	Anticline
				Fault
1009-15241-4 01	X	X	X	Dendritic Drainage
1009-15241-5 01	X	X	X	Fold
1009-15241-6 01	X	X	X	Gap
1009-15241-7 01	X	X	X	Lineament
				Mine
				Meander
				Piedmont
				Rectangular Drain
				Synclinal Valley
				Syncline
1062-15190-4 01	X	X		Alluvial Plain
1062-15190-5 01	X	X		Alluvial Terrace
1062-15190-6 01	X	X		Bay
1062-15190-7 01	X	X		Coastal Plain
				Dendritic Drainage
1080-15192-4 01				Fall Line
1080-15192-5 01				Flood Plain
1080-15192-6 01				Lineament
1080-15192-7 01				Piedmont

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PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*			DESCRIPTORS
	Lake	River	Clouds	
1024-15064-4 01	X	X		Coast Line
1024-15064-5 01	X	X		Coastal Plain
1024-15064-6 01	X	X		Flood Plain
1024-15064-7 01	X	X		Dendritic Drainage
				Lineament
1096-15065-4 01	X	X		Basin
1096-15065-5 01	X	X		Piedmont
1096-15065-6 01	X	X		Meander
1096-15065-7 01	X	X		Bedding
1045-15245-4 01	X	X		Alluvial Plain
1045-15245-5 01	X	X		Anticlinal Mtn.
1045-15245-6 01	X	X		Anticlinal Valley
1045-15245-7 01	X	X		Anticline
				Basin
1063-15245-4 01			X	Dendritic Drainage
1063-15245-5 01			X	Fault
1063-15245-6 01			X	Flood Plain
1063-15245-7 01			X	Fold
				Gap
				Geofracture
1009-15244-4 01	X	X		Lineament
1009-15244-5 01	X	X		Meander
1009-15244-6 01	X	X		Piedmont
1009-15244-7 01	X	X		Rectangular Drainage
				Ridge
				Syncline
				Synclinal Valley
				Thrust Fault
				Quarry

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DATE December 15, 1972

PRINCIPAL INVESTIGATOR Frank J. Wobber

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ORGANIZATION EarthSat

PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*			DESCRIPTORS
	Lake	River	Ridge	
1079-15124-4-01 1079-15124-5-01 1079-15124-6-01 1079-15124-7-01	X X X X	X X X X	X X X X	Basin Bedrock Dendritic Drainage Fault Lineament Monoclinal Valley Mountain Piedmont
1096-15065-4-01 1096-15065-6-01 1096-15065-7-01 1060-15062-4-01 1060-15062-5-01 1060-15062-6-01 1060-15062-7-01	X X X	X X X	X X X	Alluvial Fan Alluvial Terrace Anticline Dendritic Drainage Dome Fault Lineament Mountain Piedmont Radial Drainage Rectangular Drainage Thrust Fault Valley Volcano

*FOR DESCRIPTORS WHICH WILL OCCUR FREQUENTLY, WRITE THE DESCRIPTOR TERMS IN THESE COLUMN HEADING SPACES NOW AND USE A CHECK (✓) MARK IN THE APPROPRIATE PRODUCT ID LINES. (FOR OTHER DESCRIPTORS, WRITE THE TERM UNDER THE DESCRIPTORS COLUMN).

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DATE November 1, 1972

PRINCIPAL INVESTIGATOR Frank J. Wobber

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ORGANIZATION EarthSat

PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*			DESCRIPTORS
1059-15004-4 01				Coastal Plain
1059-15004-5 01				Coast Line
1059-15004-6 01				Dendritic Drainage
1059-15004-7 01				Lake
				Lineament
1077-15005-4 01				Meander
1077-15005-5 01				Piedmont
1077-15005-6 01				River
1077-15005-7 01				

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APPENDÍCES

APPENDIX A

APPENDIX A

TASK STATUS REPORT

TASK		STATUS	COMMENTS
PHASE I			
1.0	Establish Technical Interface With NDPF	Completed 6/30/72	Meetings held with the scientific monitor: ERTS-simulation U-2 aircraft imagery analyzed.
2.0	Assemble Geological Maps and Snow Cover Data	Completed 10/31/72	Subscription to New England Climatological Data: State geological maps of Massachusetts, Connecticut, Vermont, New Hampshire, and geological quadrangle maps for western Massachusetts purchased and analyzed.
3.0	Select and Establish Snow Points	Underway	A comprehensive net of weather stations has been organized. Physical ground points for light aircraft survey will be minimized.
4.0	Base Map & Underflight Preparation	Completed 10/31/72	Base map scale determined: Other New England investigators contacted.
5.0	Lineament Map Preparation	Completed 8/30/72	Radar imagery of Massachusetts, Connecticut, and Rhode Island was intensively analyzed to prepare geological lineament maps of the test area.
6.0	Snow Cover and Snow Melt Survey	Completed 12/31/72	Survey package designed and sent to newspapers in low density snow depth reporting areas. Readers indicating interest have been supplied with snow-depth reporting materials.
PHASE II			
1.0	Select & Analyze Snow Free ERTS Imagery	Underway	All ERTS-1 imagery of the test area analyzed upon receipt. Images 1096-15072-5 & 7 and 1096-15065-5 & 7 of the New England Test area and 1062-15190-5 & 7 of the Maryland Test area are being enlarged to a 1:250,000 scale to serve as a photo base map.

TASK	HEADING	STATUS	COMMENTS
2.0	Analyze Snow Covered Imagery	Not Available For Test Area	(Awaiting NASA Aircraft Overflight)
3.0	Prepare & Submit A Preliminary Data Analysis Plan	Completed 12/31/72	A Data Analysis Plan has been submitted to the ERTS Contracting Officer and approved.
		PHASE III	
1.0	Modify Manual Optical & ADP Enhancement Techniques.	Underway	A re-evaluation of techniques and approach has been conducted. No major changes appear necessary.
2.0	Process ERTS Imagery Through Last Snow-Covered Period.	Not available for test area.	
3.0	Prepare Final Report	Underway	Sections of Final Report are being written as the experiment progresses. Sections I and II (Introduction and Background) complete in draft form.
4.0	Prepare NDPF User Manual	Awaiting Arrival of ERTS-1 Snow-Covered Imagery	

 - Completed Tasks

RE: SR #141, Snow Enhancement

Dear Sir:

As a part of the NASA funded experiments utilizing the ERTS-1 satellite, Earth Satellite Corporation (EarthSat) is conducting a geological experiment in the New England and Maryland areas. A brief description of the experiment and a summary of the Earth Resources and Technology Satellite (ERTS) Program is enclosed. We believe that this experiment will interest your readers and provide them with what may prove their only opportunity to participate in a NASA satellite experiment.

EarthSat would like to strengthen its present snow depth reporting network by attempting to enlist public support. We believe that local newspapers are the most effective means of contacting the general public, and therefore, ask that you print our appeal for snow depth reporting volunteers to make this experiment a success.

You may include the enclosed summary in its present form or edit it as you wish. Further information about our company or the experiment will be supplied upon request. Your cooperation in assisting NASA in establishing a more effective snow depth reporting network would be appreciated.

Sincerely yours,

Frank J. Wobber
Director
Geosciences and Environmental
Applications Division

Enclosure

cc: Lowman
Fihelly

APPENDIX B

ERTS SATELLITE SNOW ENHANCEMENT EXPERIMENT

America's first Earth Resources Technology Satellite (ERTS-1) was launched on July 23, 1972 and is returning high-quality pictures of the earth's surface from an altitude of over 500 miles. ERTS-1 is the first of two satellites to be launched as part of NASA's Earth Resources Technology Program, one of the most significant of the U.S. Space efforts. The ERTS Program gathers information about farms and forests, oceans and rivers, and many other aspects of our environment.

ERTS-1 circles the earth every 103 minutes, completing almost 14 orbits each day. The satellite passes over the same place in the United States every 18 days and has a design life of one year. The data ERTS gathers is being evaluated by hundreds of scientists in universities, government agencies, and industry to determine the usefulness of this information toward solving problems of the earth's environment and its resources. As techniques for making reliable decisions are developed the nation can begin moving towards development of a permanent earth resources survey system.

Earth Satellite Corporation (EarthSat) of Washington, D.C. is conducting an experiment using imagery from the ERTS satellite to evaluate the ability of varying stages of snow cover to enhance or

accentuate certain geological features. The principal investigator, Dr. Frank J. Wobber and his co-investigators believe that by monitoring snow cover changes (snow melting) using repetitive ERTS satellite overflights, valuable information can be gained on the location of fractures, faults, and other geologic features. Fractures and faults are breaks or separations in bedrock which are important to geologists as they represent hazardous areas of potential bedrock slippage in excavations. They also tend to be zones of intense mineral concentration which could be of high economic value. Snow melting may accentuate subtle fractures and faults which stand out from the surrounding terrain because they have higher moisture contents and snow will melt off of them more rapidly.

Snow data will be acquired throughout the winter to determine the influence of snow depth in the detection of fractures and faults. Presently, co-operative weather observers (most of whom also report for National Weather Service) are recording once-weekly measurements of snow depth on pre-addressed postcards which are returned to EarthSat where they are recorded on a master snow depth map. Measurements are made by simply dipping a ruler into the snow on a level area and recording the depth measurement to the nearest inch. The present snow reporting network needs to be strengthened by increasing the number of snow depth observers.

Anyone who is interest in participating in the experiment on a volunteer basis as a snow depth observer may write to:

EARTH SATELLITE CORPORATION
1771 N Street, N.W.
Washington, D.C. 20036

Attn: Mr. Kenneth Martin

Those who are selected as observers, will receive a supply of weekly snow depth reporting postcards stamped and pre-addressed to EarthSat and a list of dates the satellite will overfly the New England area. EarthSat would be pleased to send each observer an ERTS satellite photographic print of his area on completion of his weekly reporting duties. In addition, his or her name will be listed in the final report of the investigation which will be sent to NASA. Snow depth readings are necessary in determining the influence of various depths of snow-cover on the detectability of fractures and faults from ERTS-imagery.

APPENDIX C

APPENDIX C

EARTH SATELLITE CORPORATION
(EarthSat)

1771 N STREET, N.W., WASHINGTON, D.C. 20036 / (202) 785-1123

Dear Colleague:

Your expression of interest in participating in our ERTS experiment is appreciated. Presently, the ERTS-1 satellite is relaying imagery of quite excellent detail over the eastern seaboard.

With this letter, you will receive a supply of Snow Depth Reporting Postcards, stamped and pre-addressed to Earth Satellite Corporation, upon which you may record your snow depth measurements.

We would like to have snow depth data reported on a weekly basis. Readings taken towards the middle of the week (on Wednesday) would be most desirable. A list of dates when the ERTS satellite will pass over your area is enclosed. When these dates occur, readings should be taken on them in place of the weekly Wednesday reporting. However, the readings should be made when convenient to you and a difference of one or two days in reporting time may not be critical. The readings may be made during the day or night. Postcards should be mailed as soon as possible after you have recorded your measurements.

Referring to the four topographic situations on the snow depth reporting postcard, it is not necessary for snow depth readings to be taken in all four situations. A reading at one situation will satisfy our minimum needs. However, readings obtained at more than one situation will furnish information of added value. Readings may be made by simply dipping a ruler into the snow and recording the depth to the nearest inch.

The station name and number on the postcard refer to the names and numbers of National Weather Service stations that also report snow depth data to us. In the blank labeled "Station Name" you may include the name of your town. In the space for the "Station Number" please write your street (or route) address. In the "Remarks" section it would be helpful if you could give some type of geographic reference (e.g., 2 miles SE of Amherst, Massachusetts on Route 9) which would help us pinpoint your location by latitude and longitude. Telephone numbers, which could also be written in the remarks section, may be useful in promoting future information exchange.

Your continued interest and support in our experiment is greatly appreciated. Please feel free to contact us if any questions arise or if additional clarification is needed on topics discussed in this letter.

Sincerely yours,

Frank J. Wobber
Director
Geosciences and Environmental
Applications Division

FJW/rlt

Enclosure

APPENDIX C

SNOW DEPTH REPORTING POSTCARD

Observer:_____ Station Name:_____

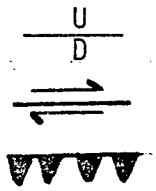
Location:_____
(County) (State)

Station Number	Snow Depth - Inches (average)	Location	Observation Date (numerical)
	___inches on...	Hilltop	
	___ " on...	Hillside	
	___ " in...	Valley Bottom	
	___ " on...	Plain (level area)	

Remarks:

APPENDIX D

PHOTO-ANNOTATION SYSTEM:
GEOLOGICAL LINEARS

SYMBOL	DESIGNATION	DEFINITION
------	Lineament	An essentially rectilinear feature that appears to be structurally controlled. A degree of uncertainty exists with respect to specific genesis, e.g. bedding, foliation, lithological boundary of this feature.
———	Fracture	A rectilinear feature which is the surface expression of a break in the underlying bedrock, but has no obvious offset.
	Fault	A fracture or fracture zone along which there has been displacement. Standardized geologic symbols indicating direction of movement will be displayed where appropriate.

APPENDIX E

SEQUENTIAL SYSTEM FOR LINEAMENT VALIDATION[1/]
(12-15-72)

	VALIDATION	
ORDER	SOURCE	RATIONALE
1	3-Interpreter Sequential Analysis	Lineaments mapped on overlays by one interpreter will be reinforced or eliminated by succeeding interpreters in a 3-interpreter sequential rotation of analysis.
2	Comparison with Topographic Maps	Topographic maps of the test area will be analyzed in sequence from small scale to large scale to check the coincidence of interpreted lineaments with cultural lineaments e.g., pipelines, transmission lines, highways, ski slopes, etc. A negative correlation of interpreted lineaments with existing cultural lineaments would indicate a geological origin.
3	Comparison with Radar Lineament Map	A geolineament map prepared from analysis of radar mosaics will be used to further validate the geological origin of interpreted lineaments.
4	Comparison with Geological Maps	Geological Maps will be analyzed in sequence from small scale to large scale to check the coincidence of interpreted lineaments with mapped fractures or faults. The geological nature of the lineaments, e.g. structure, lithology, foliation, etc. may be determined so this information can be displayed on annotated enlargements.
5	Field Observation	Interpreted lineaments may be validated through direct field observation by EarthSat Scientists.

1/ The geological validity of the image-identified lineament may be established by one or all of the final four steps in the validation order. It is likely that most lineaments will have had their validity determined before step five as in most cases field observation probably will not yield more information than can be obtained in steps 2-4. A lineament that cannot be validated in the above system will be deleted from the overlay. The above approach is subject to modification.